CHARGE DEPOSITIONS IN THE APA GAPS

CHARACTERISING THE 35T ACTIVE VOLUME & MEASURING CHARGE LOSS

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IN THIS PRESENTATION

- Used simulated anti-muons to characterise the active volume that extends beyond the TPC edge wires in Y and in Z.
- Produced plot of the charge ratio (Defined as the edge channel charge sum divided by the average hit channel charge sum of the hit wires in the same TPC) against extension of particle path into the active drift volume.
- Produced plot of the charge sum per channel, for different anti muon samples which have varying trajectories in Y but are all parallel to +Z, against channel number.
- Outline of change in V5 of the geometry.
- Outline of plan and progress with regard to measuring the charge loss in the gaps. Divided into two tasks:

1: Measure the width of the gaps (simulation may not match reality) ☒ In progress

2: Use ratio effect to evaluate charge loss for a known gap width ☑ Complete

•Fired 5 GeV muons with different origins across active volume of TPC.

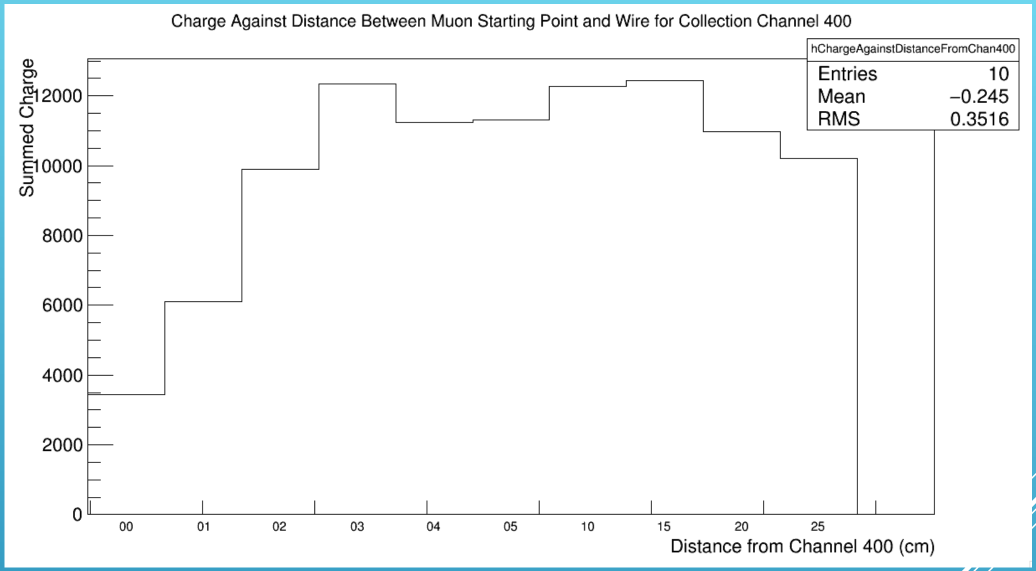
•Muon trajectories were parallel to the z-axis.

•Plotted the summed charge for each sample against the samples origin with respect to the edge channel of TPC1.

•The longer the path length experienced by the edge channel, the larger the charge deposited.

•This effect is true provided that the track does not exceed ~'-3cm' in z.

•The active volume starts at approximately -3cm in z.



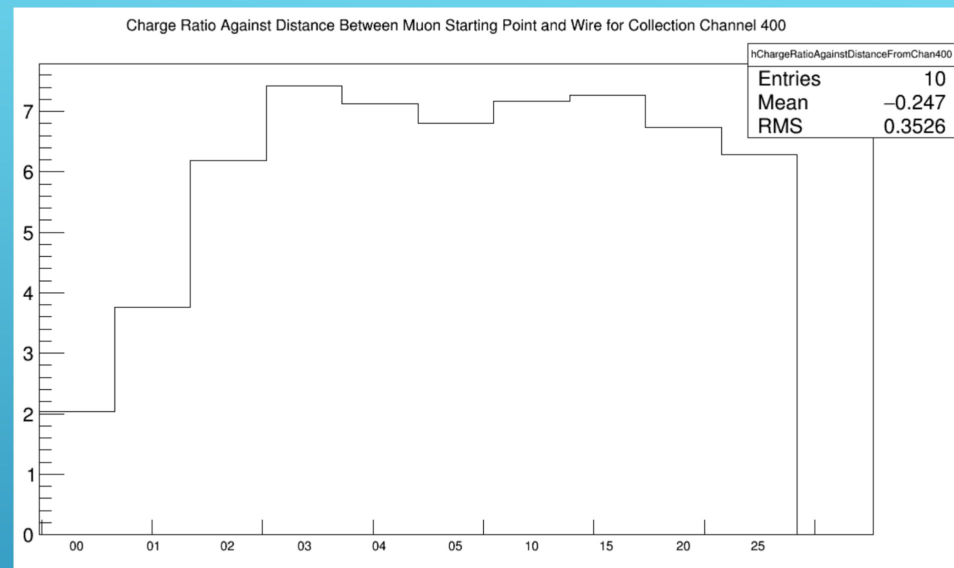
CHARACTERISING THE DRIFT VOLUME IN Z – EXTREMAL EDGE CHANNELS

•Made the analogous plot to the previous slide with the charge ratio in place of summed charge on the y axis.

•Charge ratio is defined as summed charge on the edge channel (400) divided by the summed average charge experience by hit collection wires in the same TPC.

•The charge ratio is only dependent on on the charge lost in the active volume region that extends below z=0cm.

•Again, observe an effect until z = -3cm where after increases in track length, wrt z, do not increase the charge experienced by the edge channel.



CHARACTERISING THE DRIFT VOLUME IN Z

- Channel 400 is located at 0.75cm in z.
- Each TPC wire experiences 0.44906cm of active Z volume.
- 3 GeV Gap 1 + 2
  TPC 1 edge channel 400 experiences (Using extrapolation) 2.78259cm of active Z volume
  TPC 7 edge channel 2047 experiences (Using extrapolation) 2.48507cm of active Z volume

  6 Gev Gap 1 & 2
  TPC 1 edge channel 400 experiences (Using extrapolation) 2.87864cm of active Z volume
  TPC 7 edge channel 2047 experiences (Using extrapolation) 2.59468cm of active Z volume

  10 GeV 1 & 2
  TPC 1 edge channel 400 experiences (Using extrapolation) 2.65089cm of active Z volume
  TPC 7 edge channel 2047 experiences (Using extrapolation) 2.36588cm of active Z volume

  10 GeV Gap 2 only
  TPC 7 edge channel 2047 experiences (Using extrapolation) 2.38738cm of active Z volume

RESULTS OF USING CHARGE RATIO AND NO CHARGE LOSS TO WORK OUT ACTIVE VOLUME EXTENSIONS

•Made samples of 5, 5GeV anti-muons.

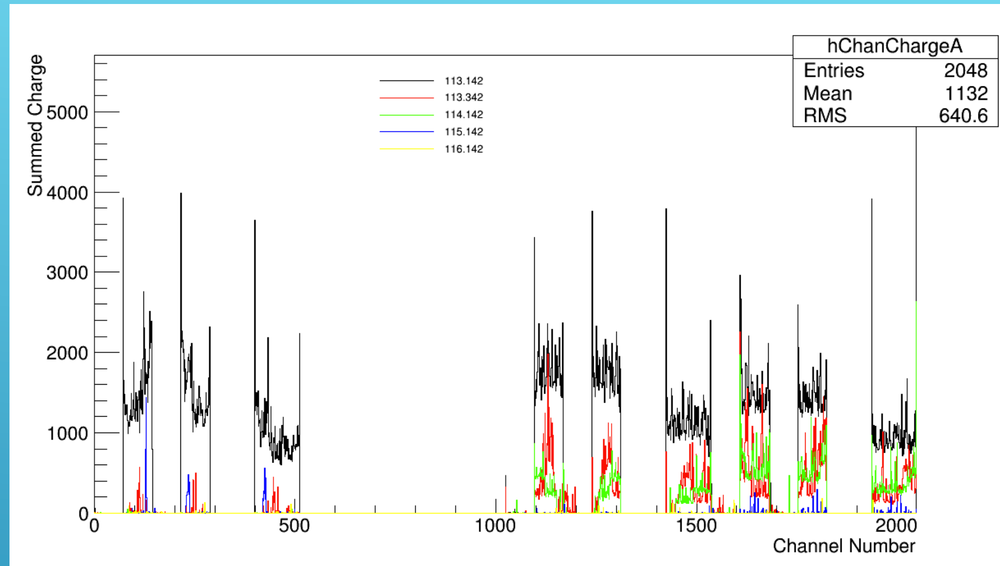
•They move parallel to +Z, with constant X=100cm.

•Y is varied between samples.

•Plot shown is of the summed charge, for all 5 events in each sample, against channel number. There are 5 samples shown in different colours.

•Used V4 of the geometry for this study.

•Updated this study for the V5 geometry as outlined on the next slides. Haven't show results as there's a bug lurking somewhere.



CHARACTERISING THE DRIFT VOLUME IN Y

•Zoom in on the channels corresponding to TPC1 (less subject to deflections than the higher numbered TPCs)

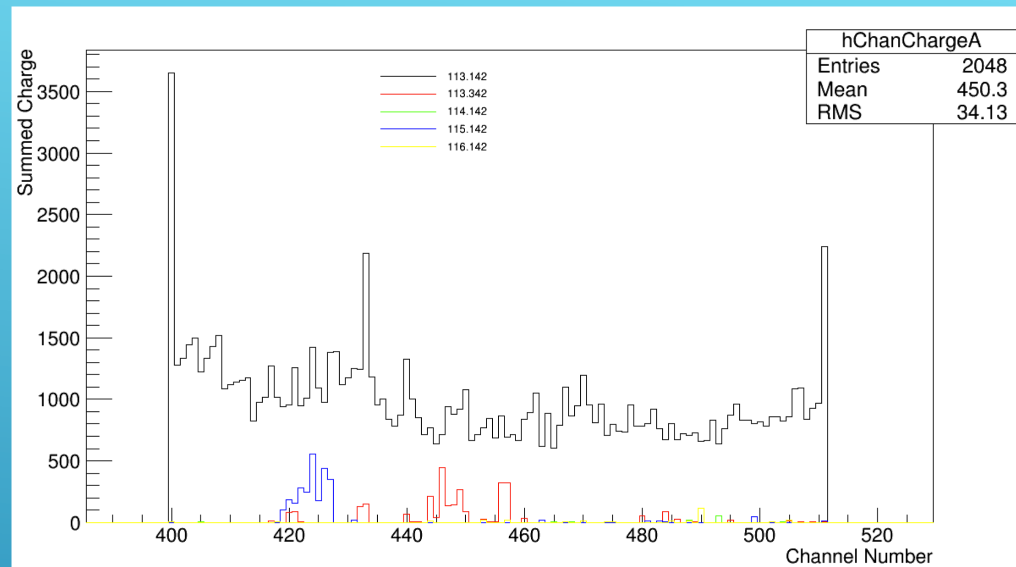
•Channel numbers are 400-511 in TPC1.

•Can clearly see that nearest wire does not drift the charge to the nearest wire when the charge deposits extend beyond the active volume Y, which ends at 113.142cm.

•The charge that is present for samples of y>113.142cm is accountable for (and visible in EVD) as delta rays or deflections that deposit charge in the active volume.

•New Geometry extends to the field cage, which is just shy of the edge of the APA in Y.

•This is the expected behaviour.



CHARACTERISING THE DRIFT VOLUME IN Y

	Cryo	TPC0	TPC1	TPC2	TPC3	TPC4	TPC5	TPC6	TPC7
-X(cm)	-58.09	-35.18	-1.48	-35.18	-1.48	-35.18	-1.48	-35.18	-1.48
+X(cm)	349.47	-6.55	222.46	-6.54	222.46	-6.55	222.46	-6.55	222.46
-Y(cm)	-115.26	-84.22	-84.22	-84.22	-84.22	0	0	-84.22	-84.22
+Y(cm)	155.19	115.09	115.09	0	0	115.09	115.09	115.09	115.09
-Z(cm)	-33.70	-2.04	-2.04	51.41	51.41	51.41	51.41	103.33	103.33
+Z(cm)	236.80	51.41	51.41	103.33	103.33	103.33	103.33	156.78	156.78

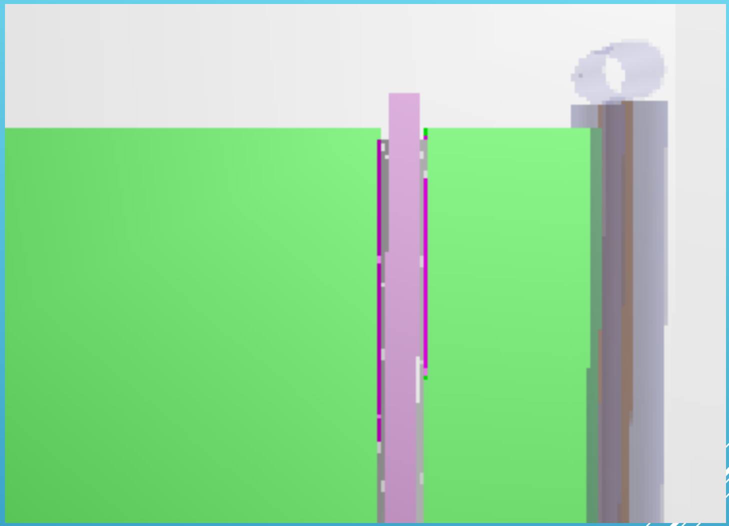
Parameters and new geometry courtesy of T. Alion

NEW GEOMETRY V5 - DEFINED ACTIVE VOLUME REGION

New geometry has been extended such that the active volume now ends at the field cage.

Previous version had the active volume such that it extended to the APA edge.

The render to the right shows the active volume as a green region. The new active region, in +Z just below the purple APA, is clearly visible.



CHANGE TO 35T GEOMETRY V5 (T. ALION)

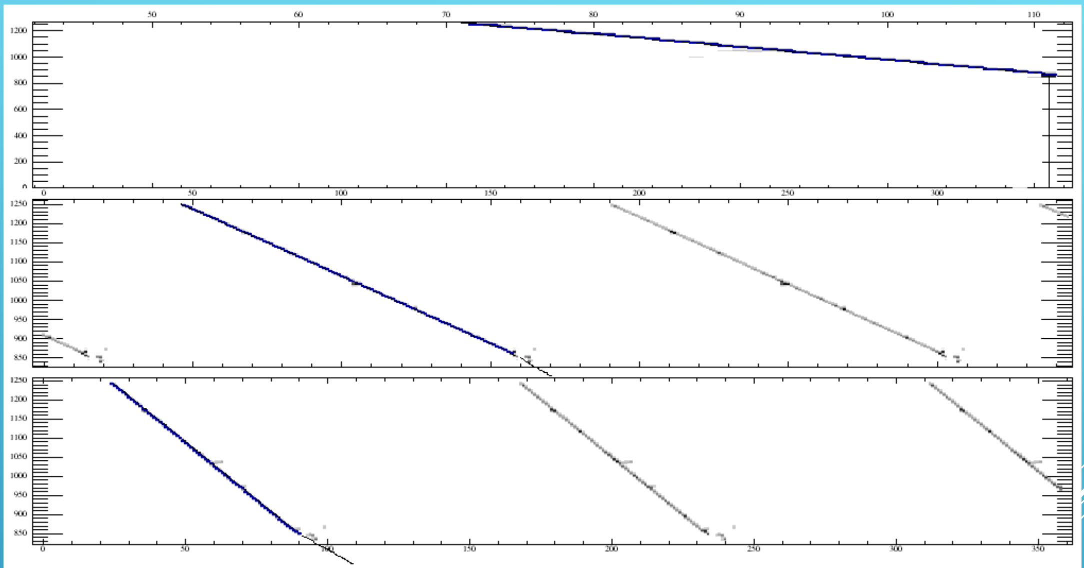
•All previous slides have dependence on a *known* charge loss in gaps and a *known* active volume.

•Charge loss is set to be zero in the previous slides. This is idealised. Need method to determine Q_{lost} in 35t actuality.

•Michelle has suggested a method for doing this using unstitched, reconstructed, tracks.

•To the right is the event I generated to study this. Θxz & θ yz are both inclined at -60 degrees.

•This 5GeV muon crosses the gap between TPC 1 and 5 and between 3 and 5 (the horizontal middle gap.



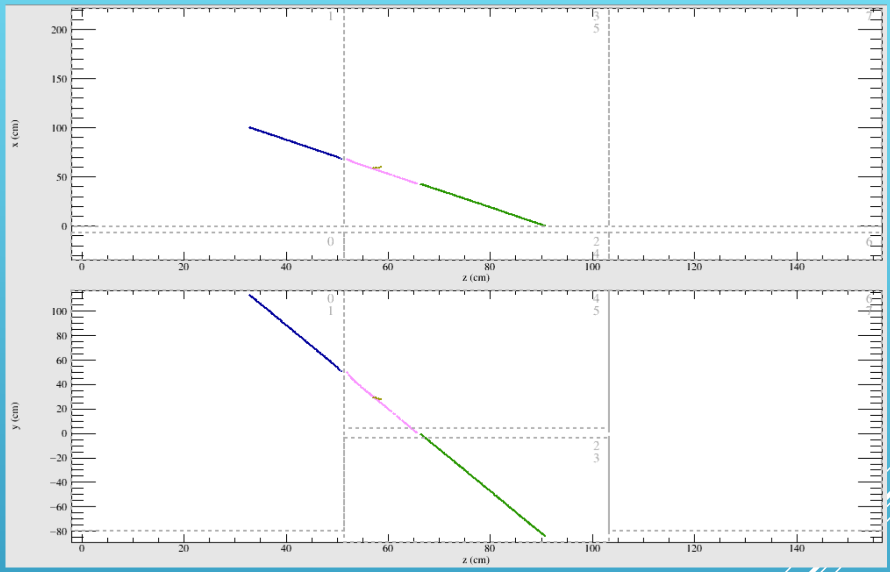
MEASURING CHARGE LOSS IN THE GAPS

•The reconstructed tracks are shown in the EVD to the right. Different colours represent different, unstitched, track segments.

•Used pmtrackdc, written by Robert.

• Vary gap width dZ such that unstitched track elements are perfectly aligned. Assuming good reconstruction on well characterised events, this allows determination of the gap width.

•But it has a couple of problems at present!



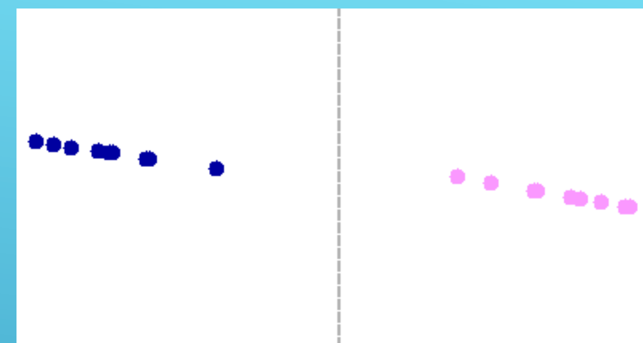
MEASURING CHARGE LOSS IN THE GAPS – DETERMINE GAP WIDTH

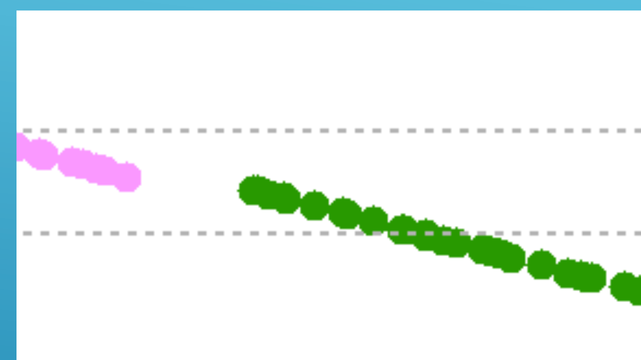
•The pmtrackdc algorithm has some distortion effects at the edges of TPCs.

•The pmtrackdc plots space points outside of the TPC regions.

•In order to calibrate correctly need to remove the above two effects. Without this, the alignment will happen at the wrong value of dZ.

•Robert has graciously offered to change a parameter in the algorithm such that I can adjust this. Thanks!





MEASURING CHARGE LOSS IN THE GAPS – DETERMINE GAP WIDTH

- Determine gap widths using a method not dependent on unknowns without MC truth.
- Use dQdx to work out charge loss in gaps (This is done, but needs to be implemented after determining gap width)
- Use dQdx to work out charge effects on the extremal edge channels.
- Study effect of charge lag (increase in time for charge reaching channels over a larger active volume) on the hits themselves – expect broadened hits with the same start time.
- Determine how to get T0 for the sample used. Can use counters initially, which readily capture events crossing gaps 1 & 2. Would like to use photon detectors thereafter to characterise gap width across all of 'Y' – TPC's may not be perfectly aligned.

TO DO

- New version of geometry will have active volume adjustments to extend to the boundary set by the field cage.
- The new active volume ends just shy of the APA in Y.
- The new active volume extends ~2.8cm in +Z and –Z.
- Have written the gap filtering module to isolate gap crossing events. Can use counter sample initially, and migrate to photon detectors when possible.
- Determining charge loss is simple provided we know the gap width exactly.
- Determine gap width by aligning unstitched tracks and matching the gap width dZ such that the tracks are perfectly aligned either in each of the TPCs.
- A variable gap width does not make this harder, but statistically limits the information.

CONCLUSIONS